WORLD SHRIMP PRODUCTION

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Total world shrimp supply at the end of the 1990's is expected to exceed 3×10^6 t. In 1989, 103 counties were involved in shrimp production; 10 of the top 16 counties were Asian and together produced more than half the worlds production. Tropical shrimps represent 90% of the world shrimp market. The production from wild harvest fishing operations is fully exploited and will remain static at *ca.* 1.5×10^6 t. Shrimp production from aquaculture has shown a dramatic increase over the last 10 years due in part to the development of hatchery techniques and the production of hatchery reared post-larvae. The culture is centred on tropical prawns (*Penaeus* species) grown in Southeast Asia. Latin America has the potential to be a large producer of aquaculture product but its development is hampered by lack of technical expertise and capital. ☐ *Shrimp, prawn, aquaculture, wild harvest, fisheries, world.*

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Shrimp are found in all regions of the world in fresh, coastal and oceanic waters. Many species have high value and form the basis of major commercial wild harvest fisheries and culture industries. There are five major market groups of shrimp:

1. Warmwater or tropical marine species. They mature rapidly and often grow to a large size.
2. Coldwater marine species. Inhabit temperate waters, grow slowly and are generally small.
3. Freshwater species. Live in inland water bodies and rivers, mostly in the tropics and often grow to a very large size.
4. Deep sea shrimp. Grow and reproduce slowly and are of limited commercial value.
5. Krill. Landings of Antartic krill (*Euphausia superba)* topped 500,000 t in 1989. The biomass is estimated at 100×10^6 t. New uses of krill by-products and increasing use for human consumption (e.g. in Japan) should encourage more attention to this species.

The world supply of shrimp increased rapidly from 1.09×10^6 t in 1970 to 1.63×10^6 t in 1977 (live weight). Supply of shrimps remained relatively stable until 1981, when landings quickly accelerated to reach about 2.5×10^6 t by 1989.

According to FAO statistics in 1989, 103 countries were involved in the production of shrimp, both wild and cultured. Ten of the top 16 producing countries in 1988 were Asian and together produced 1.6×10^6 t (live weight), equivalent to 65% of the total world production (Table 1). For 1989 this should increase further as a result of continued strong cultured shrimp output.

Estimates reveal that 90% of the total world market supply consists of tropical shrimp.

Coldwater shrimp landings have shown considerable fluctuations, mainly due to incompatible fishing efforts and the natural characteristics of the resource (slow growth and rate of recovery). This has led to major collapses: United States Pacific fishery in early 1980's, Norway

TABLE 1. Sources of shrimp production ($\times 10^3$ t), by principal country.

Country	1980	1985	1986	1987	1988
China	184	367	427	457	584
India	250	232	215	197	237
Indonesia	136	144	157	187	202
USA	162	153	183	165	151
Thailand	133	126	139	150	*150
Taiwan	81	108	137	176	111
Ecuador	17	36	53	79	81
Philippines	26	62	72	68	80
Mexico	77	75	73	84	73
Malaysia	84	69	73	*73	*73
Greenland	36	52	64	64	65
Brazil	48	68	55	55	58
Vietnam	41	54	55	56	*56
Rep. of Korea	27	40	45	48	50
Japan	51	55	48	48	*48
Norway	45	91	57	42	42
Australia	22	21	19	20	20
World Production	1,781	2,298	2,426	2,605	2,763

*Estimated.

TABLE 2. Catches of coldwater shrimps ($x10^3$ t), by selected countries.

Country	1980	1985	1987	1988
Greenland	35.8	52.4	64.4	65.1
Norway	45.3	91.2	42.2	41.7
USA	44.7	19.5	37.8	36.7
Canada	12.0	14.1	25.4	34.5
Iceland	10.0	24.9	38.6	29.6
Denmark	7.0	10.3	16.1	*16.1
USSR	12.1	33.4	12.0	13.7
FR Germany	15.4	17.7	17.0	14.3
Argentina	0.8	10.3	2.8	*2.8
Total	183.1	273.8	256.3	254.5

*Estimated.

and Argentina in 1986. Most of the fisheries appear to have recovered (Table 2) and fishing is now strictly regulated. No major increases are expected for this group and aquaculture has limited potential.

Freshwater shrimp output has remained stable. Initially, demand suffered as marine shrimp supplies increased. However demand is now increasing, due mainly to market demand for large shrimp. Smaller shrimp are used as market subsitutes for small marine shrimp e.g. *Crangon* spp.

The growth in production of cultured shrimp (mainly *Penaeus* species) has been spectacular. In tropical coastal countries, using simple earth ponds, tidal or pumped water supplies, local or hatchery-reared seed, and simple fertilisation or feeding, a marketable crop of 15–30g shrimp can be reared in as little as 3 or 4 months. Annual yields range from 200 to 500 kg ha^{-1} in simple extensive tidal ponds, to upwards of 10 t ha^{-1} in modern intensive systems using formulated feeds, aeration and regular water exchange.

In production terms, the results of the blue revolution have been impressive. In 198l, cultured shrimp accounted for only 2.1% of total world shrimp harvest, while in 1989 this was estimated to have reached 27% with output of 560,000 t, corresponding to a farm-gate market value of about US$2.5 billion. Much of this originates from the developing world, particularly Southeast Asia and Latin America.

As a result of this development, rural coastal land of limited agricultural potential, has acquired a new status. There are also new prospects for income and employment; traditional brackish water fishpond operators have a new source of income; fishing communities can get involved in catching seed shrimp and broodstock; farm and hatcheries in rural areas offer local employment and training for young people. There are new services industries; in Southeast Asia backyard hatcheries have created excellent opportunities for small family-based business, whose earnings in turn give stimulus to local economies. These spin-off benefits can be simply staggering, which is probably a major reason why governments continue to be keen to promote this activity despite the current problems on the marketing level.

The producing countries are discussed on a regional basis below(including the smaller producers, some of which are major suppliers to select markets) , followed by an overview of the international trade for shrimp and prospects for future markets.

EUROPE

Capture Fisheries

European Economic Community (EEC)'s dom-

TABLE 3. Cold water shrimp production ($x10^3$ t) from selected countries in the European Region.

Country	1982	1983	1984	1985	1986	1987	1988
Pandalus borealis							
Norway	51.6	78.2	84.0	91.2	57.4	42.0	40.0
Iceland	9.2	13.1	24.4	24.9	35.8	38.6	30.0
Greenland	40.7	41.2	41.5	52.4	64.1	64.1	72.5
Denmark	7.1	10.1	7.3	9.4	10.0	14.3	8.3
Others	7.5	9.2	11.2	13.6	12.1	11.6	*12.0
Total	**116.1**	**151.8**	**168.4**	**191.5**	**179.4**	**170.6**	**162.8**
Crangon crangon							
Germany	19.8	13.4	12.0	17.7	17.0	17.0	*17.0
Netherlands	7.3	7.0	*7.0	*7.0	*7.0	*7.0	*7.0
France	1.4	1.1	1.4	1.0	1.5	1.0	*1.0
UK	1.2	0.8	0.4	0.4	1.0	2.0	1.3
Total	**29.7**	**22.3**	**20.4**	**26.1**	**26.5**	**27.0**	**26.3**

*Estimated.

TABLE 4. Shrimp production ($x10^3$ t) by countries within the European Economic Community.

Country	1982	1983	1984	1985	1986	1987	1988
Germany	19.8	13.4	12.0	17.7	17.0	17.0	14.3
Spain	11.3	11.5	12.2	29.3	23.4	25.1	22.0
Denmark	10.2	12.1	8.1	10.3	11.2	16.2	6.8
Netherlands	7.3	7.0	*7.0	*7.0	*7.0	*7.0	*7.0
Italy	10.3	12.7	17.8	20.2	14.6	12.1	16.4
Greece	2.3	2.4	2.6	3.1	3.7	5.9	4.4
Ireland	0.1	0.1	0.1	0.1	0	0	0
Belgium	2.2	1.0	1.0	0.9	0.6	0.8	0.7
Portugal	0.4	0.7	0.8	0.7	0.2	0.2	0.2
UK	1.2	1.1	0.7	0.8	1.4	2.5	1.6
France	3.2	2.4	2.9	2.1	2.8	2.6	2.3
Total	68.3	64.4	55.2	85.2	81.9	89.4	75.7

*Estimated.

estic production of shrimp increased from 60,000 t in 1981 to over 80,000 t in 1987 (Table 4). Most of this production is made up of *Crangon crangon*, a small coldwater species caught by the fleets of Germany and the Netherlands (Table 3). Spain and Italy contribute *c.* 15,000 t of *Parapenaeus longirostris*, a warmwater species.

From the early 1970's European and North Atlantic catches of *Pandalus borealis* increased steadily from 30,000 t to a peak of 192,000 t in 1985. Since then the landings have declined, due to smaller catches by Norway, to 163,000 t in 1988 (Table 3). Norway used to account for roughly half of the world's *Pan. borealis* landings, but Greenland with 72,500 t in 1988 has become the leader. Iceland's catch of this species tripled between 1983 and 1986. However stock started to decline due to overfishing. Quotas were introduced with the result that catches dropped from 39,000 t in 1987 to 30,000 t in 1988.

Spanish shrimp production reached a peak of 25,000 t in 1985, due to record catches of *Par. longirostris*. Landings then declined to 19,000 t where they have remained. Coldwater shrimp represent a very small proportion of the Spanish shrimp catch. Domestic supply accounts for approximatelty half of the total shrimp consumption in Spain.

UNITED STATES OF AMERICA

Capture Fisheries

The United States domestic shrimp production was 331 x 10^6lbs (150,000 t) in 1988 (Table 5) and comprised about 7% of the world's supply. United States total shrimp landings increased from 192 x 10^6lbs (73,000 t) in 1950 to a record level of 467 x 10^6lbs (216,000 t) in 1977, the result of high landings in the Gulf of Mexico fishery and a record harvest of cold water shrimps production in subsequent years, United States total landings averaged 329 x 10^6lbs (150,000 t) during the period 1980–88, as compared to an average of 391 x 10^6lbs (178,000 t) for the period 1971–79. However the total deflated ex-vessel value of shrimp has shown an overall rising trend during the period 1971–88.

Landings of coldwater shrimp increased rapidly up to 1977, largely as the result of heavy production in Oregon and Alaska. The number of trawlers in the Pacific fishery has since declined. A combination of declining shrimp stocks and reduced prices caused by imports of coldwater shrimp from Norway led to a major drop in Pacific landings during the 1983–85 period. In addition, many production areas in Alaska were closed to permit the resource to recover. Since 1985 catches have improved in Washington, Oregon and California, but a high incidence of small-size shrimp at times has resulted in lower ex-vessel prices. Alaskan stocks show no signs of recovery.

The tropical shrimp fishery has not undergone major fluctuations in recent years. This fishery averaged 253 $x10^6$lbs y^{-1} (115,000 t y^{-1}) during the period 1980–88. Since all major United States shrimping grounds are already exploited to a maximum, the total supply from the warmwater capture fisheries is not expected to increase in the future.

TABLE 5. Shrimp Production ($x10^3$ lbs), by regions, in the United States of America.

Year	Mid Atlantic	South Atlantic	Gulf	Pacific	Total
1971	24,536	31,200	227,367	107,790	390,902
1972	24,461	25,248	228,941	108,811	387,461
1973	20,739	24,557	182,206	152,220	379,722
1974	17,515	27,091	186,208	142,759	373,573
1975	11,655	24,926	170,083	149,067	346,731
1976	2,254	26,108	210,167	167,865	406,394
1977	840	18,021	265,158	192,433	476,452
1978	-	20,138	248,327	154,403	422,875
1979	1,072	32,295	206,564	96,019	335,950
1980	731	32,996	208,280	97,697	339,704
1981	2,271	16,514	268,190	67,496	354,471
1982	3,383	25,580	209,926	44,738	283,627
1983	3,469	26,615	198,457	21,124	249,664
1984	7,114	19,179	254,254	20,807	301,354
1985	9,254	27,970	262,908	33,509	333,641
1986	10,328	23,120	304,051	62,686	400,185

There has been a steady increase in the number of vessels in the fishery for tropical shrimp in the past 10 years. Between 1978 and 1987 the number of shrimp vessels (fishing craft over 5 t gross) in the Gulf of Mexico rose from 3,743 to an estimated 5,800. At the same time, shrimp vessels have become large and more sophisticated.

The Gulf of Mexico shrimp trawlers reportedly operated profitably during the period 1971–80. This trend stimulated the continued expansion in the fleet, despite periodic downturns in shrimp prices and generally rising operating costs. Historically the Gulf of Mexico shrimp fishery has displayed symptoms of overcapitalisation, but regulatory efforts to limit access have generally not been acceptable to the United States industry.

Culture

Total cultured tropical shrimp production was c.1,100 t in 1988. Climate conditions, high labour costs and shortage of suitable land have generally resulted in United States investors going abroad. Initially this was Latin America. Currently the focus of United States investors is Southeast Asia (Thailand, Philippines and Indonesia).

MIDDLE EAST AND NORTH AFRICA

Capture Fisheries

Total shrimp production in Middle East and North African countries was probably between 20,000 t and 30,000 t in 1988. Shrimp is caught both by industrial trawlers and by artisanal fishermen.

The principal shrimp catching countries in the region are Algeria, Bahrain, Egypt, Kuwait, Saudi Arabia and Tunisia (Table 6). Most fisheries for shrimp in the region are considered to be fully exploited. However, there may be scope for increased landings in Algeria, Qatar and the Yemen Arab Republic.

Culture

Although there is some experimental activity in a number of countries in the region, there are no commercial shrimp culture operations.

There are major constraints to the development of shrimp culture, including the availability of suitable species, lack of freshwater, and soil and climatic conditions. In the Middle East countries it is anticipated that little progress will be made, but a country such as Tunisia may be able to develop a shrimp culture industry.

Exports

Total shrimp exports from the Middle East and North Africa were less than 10,000t in 1988.

The principal exporting country in 1988 was Tunisia, which in that year shipped over 3,000 t. Other countries in the region normally export

TABLE 6. Shrimp production (t) from selected countries in the Middle East and North African Region.

Country	1985	1986	1987	1988
Algeria	n/a	5,277	8,750	6,056
Bahrain	1,324	1,733	1,843	1,118
Eygpt	1,939	1,717	2,150	n/a
Kuwait	2,128	1,667	2,443	4,999
Oman	n/a	n/a	200	n/a
Qatar	53	56	61	100
*Saudi Arabia	2,600	1600	2260	2600
Tunisia	1,756	2,279	3,798	3,135
Yemen (P.D.R.)	390	353	275	86
Yemen Arab Republic	320	432	361	273

* Estimated

less than 1,000 t y^{-1}. Export destinations are primarily Europe and Japan.

Outlook

There is little prospect for any increase in supply from the Middle East and North Africa. Most capture fisheries are fully exploited and culture production will be difficult to develop.

Exports from the region have little impact on world trade in shrimp. This situation is not expected to change.

WEST AND EAST AFRICA

Capture Fisheries

Total shrimp catches in West Africa have probably averaged over 30,000 t in the period 1983–86. It is likely that more than 50% was caught by vessels from non-coastal countries.

Of the West African coastal countries, Senegal is the largest producer with over 5,000 t y^{-1} in the period 1983–87. The only other coastal countries to produce consistently over 1,000 t y^{-1} are Nigeria, Morocco and Gabon (Table 7).

Spain is the leading producer of the non-coastal countries, with an average of 8,900 t y^{-1} in the period 1983–86. Its vessels operate under bilateral or EEC negotiated agreements, or joint venture agreements.

Fishing effort in West Africa has tended to concentrate on pink shrimp (*Penaeus notialis*). In several countries, notably Senegal, Cameroon, Sierra Leone and Nigeria, industry sources have expressed concern at decreasing catches and a decline in the size of shrimp caught, which can be taken as a sign of over-exploitation

It is thought likely that local fishing vessels will be directed increasingly towards catching the deepwater rose shrimp (*Par. longirostris*), which has been taken almost exclusively by the Spanish fleet. Local operators will have to invest in certain changes in equipment, notably the winches, to enable their vessels to fish at the depths required.

In East Africa the principal producing countries are Madagascar and Mozambique. In the period 1986–88, over 7,000 t and 5,000 t respectively, were caught annually.

Culture

Shrimp culture activities in Africa are still at an initial stage. While experimental work is being undertaken in several countries, there are as yet no commercial shrimp farms in full operation. Trial production is taking place in Gambia, Madagascar and Tanzania. Madagascar has the best potential.

At this stage it is not clear which shrimp species will be found suitable for culture in West Africa. Currently, West African operations work with imported species (*Pen. monodon* and *Pen. vanamei*), while in East Africa (Madagascar and Mozambique) there is a resource of *Pen. monodon*.

Exports

Western Europe has been the principal outlet for shrimp from West Africa, with France the most important market. African shrimp are very popular due to existing species/taste preference.

Japan is the principal market for exports of shrimp from East Africa (*Pen. monodon* and *Pen. indicus*).

AUSTRALIA

Capture Fishery

Australian fisheries for shrimp produce approximately 20,000 t. All Australian fisheries are managed under systems of limited entry, restrictions on gear and closed seasons.

The northern prawn fishery is the most important with landings of about 10,000 t. The resource is considered to be fully exploited. The principal species caught is the banana shrimp (*Pen. merguiensis*) which, between April and September–October, forms schools in shallow water. Other species caught include white shrimp (*Pen. indicus*), tiger shrimp (*Pen. semisulcatus* and *Pen. esculentus*), endeavour shrimp (*M. endeavouri*), western king shrimp (*Pen. latisulcatus*) and red spot king prawn (*Pen. longistylus*).

The western trawl fishery was originally directed at western school prawns (*M. dalli*). In the 1960's a modern trawl fishery began, for which

TABLE 7. Shrimp production (t) from selected countries in the West and East African Region. Source: FAO Yearbook of Fisheries Statistics and INFOPECHE.

Country	1984	1985	1986	1987	1988
WEST AFRICA					
Coastal Countries					
Morocco	1,400	1,700	1,000	1,300	2,100
Mauitania	300	200	500	600	1,200
Senegal	5,300	5,500	5,600	5,400	n/a
Gambia	500	500	500	500	500
Sierra Leone	700	700	700	n/a	n/a
Cote d'Ivoire	400	500	600	500	600
Chana	200	500	600	1,600	n/a
Nigera	2,300	1,500	1,600	2,200	2,500
Cameroon	900	600	800	800	800
Gabon	1,600	1,700	1,900	2,100	2,000
Non-coastal Countries					
Spain	9,600	10,500	5,800	n/a	n/a
Italy	600	800	1,100	n/a	n/a
Greece	1,800	2,400	2,400	n/a	n/a
EAST AFRICA					
Madagascar	6,052	6,685	7,606	9,020	7,707
Mozambique*	25,845	6,140	5,923	5,570	5,640
Tanzania	294	446	558	1,262	1,324

*Industrial fleet only

the principal species are brown tiger shrimp (*Pen. esculentus*) and western king shrimp (*Pen. latisulcatus*). In recent years catches of these species have declined sharply, leading to the closure of spawning areas. Landings from this fishery account for about 15% of the total Australian catch.

The southern trawl fishery lands only western king shrimp (*Pen. latisulcatus*). The fishery is considered to be fully expoited and has had a system of limited licences since the fishery developed in the mid 1960's.

The eastern shrimp fishery is a complex of sub-fisheries, each targeting a complex of species. The fishery is mainly based on king (*Pen. plebejus, Pen. longistylus* and *Pen. latisulcatus*), banana (*Pen. merguiensis* and *Pen. indicus*), tiger (*Pen. esculentus* and *Pen. semisulcatus*) and endeavour (*M. endeavouri* and *M. ensis*) shrimps offshore and school (*M. macleayi*) and greasyback shrimps (*M. bennettae*) inshore and in estuaries, with some deepwater species such as jack-knife prawn (*Haliporoides sibogae*) and scarlet shrimp (*Plesiopenaeus edwardsianus*) also taken.

Culture

Culture production is limited although some 40 farms are reportedly involved in this activity. Most farms use extensive technology and total production has not exceeded 1,500 t y^{-1}.

The principal culture species is black tiger (*Pen. monodon*), although there are some ongoing trials with other local species. The selection of the black tiger as the principal species puts the entire Australian culture industry in doubt as it is unable to compete nationally and internationally with SE. Asian black tiger supplies because of climatic and lower production costs.

Export

Total exports during 1988/1989 were 11,594 t with Japan as the major outlet. With its market position in Japan seriously challenged by Chinese white, and particularly black tiger, Australian exporters are successfully targeting the Spanish market for head-on shrimp.

Australia is also a significant importer. Imports are mainly from Asian countries, with Thailand, Malaysia and Vietnam the major suppliers. Annual imports are about 11,000 t, and consist primarily of cheaper products.

LATIN AMERICA

Shrimp production in Latin America is summarised in Table 8. In 1988 landings from capture fisheries exceeded 200,000 t (live weight), while cultured production was about half that volume.

The shrimp industry in Latin America developed rather favourably because it supplied a growing United States market, which was also willing to support the industry or at least invest considerable sums of money in it.

The vast majority of facilities are of United States design and are therefore set up to suit its market requirements. This is perhaps also the reason why the Latin American shrimp sector has not been very successful in penetrating other markets.

Capture Fisheries

Mexico is the largest capture fishery in the region with an annual production in excess of 70,000 t y^{-1} (live weight), followed by Brazil with 50,000 t and Argentina which has produced up to 20,000 t. Panama produces about 15,000 t. Other countries in the region normally land less than 100,000t y^{-1}. A drop in production is antic-

TABLE 8. Shrimp production ($x10^3$ t), by countries in the Latin American Region.

Country	1984	1985	1986	1987	1988
Argentina	23.1	10.3	7.0	2.8	18.1
Brazil	67.5	77.7	65.4	62.7	65.5
Chile	3.9	2.9	3.0	4.5	5.0
Colombia	8.1	5.0	6.2	6.7	5.3
Cuba	5.3	5.9	6.0	5.0	4.5
Equador	39.9	36.2	52.8	79.5	81.6
Panama	10.3	15.9	13.1	7.8	6.0
Peru	2.5	3.7	3.4	5.9	4.4
Mexico	79.9	77.9	76.3	87.1	76.9
Venezuela	5.2	6.0	6.6	6.1	5.6

ipated because of significant over-exploitation and poor management.

CULTURE

Except for Ecuador, culture output for the region has been disappointing. Currently the culture sector is passing through a very difficult phase, as a result of:

– limited availability of local and foreign investment capital.

– unfavourable climatic conditions resulting in low wild fry supply and diseases.

– hatcheries not operating or operating on limited scale only with poor results (low output and weak animals due to use of antibiotics resulting in deformities, diseases, slow growth and high mortality in grow out ponds).

– low prices in international markets.

– lack of research and development.

In the Latin American culture industry there are seven countries that deserve to be mentioned: Ecuador, Mexico, Honduras, Brazil, Peru, Panama and Colombia.

Ecuador has accounted for over 75% of the annual production of cultured shrimp in Latin America. Production in 1988 was reportedly about 75,000 t (live weight) but was expected to be approximately 10% less in 1989. No other country in the region produced more than 5,000 t. Yields vary widely. The best managed farms produce more than 2 t $ha^{-1}y^{-1}$, although the average production was estimated by industry sources at 700 kg $ha^{-1}y^{-1}$.

Ecuador is reported to have 124,000 ha of ponds, but in 1989 according to industry sources only 75,000 ha were in operation, owing to shortages of seed. Although there are about 60 hatcheries they have not been able to supply more than 25% of the farmer's need. Thus the industry is still dependent to a great extent on supplies of wild seed, which vary in abundance from year to year.

Shrimp culture in Mexico is conducted extensively in about 10,000 ha of ponds with low yields (350 kg $ha^{-1}y^{-1}$). Potentially there are 100,000 ha of land suitable for culture. Growth in the industry is constrained by lack of investment capital and by legislation reserving the ownership and use of land for cooperative groups of farmers. Nevertheless, this is all set to change from 1990 with private ownership of land and trade in shrimp possible as new legislation comes into effect.

The fastest growth in the region is taking place in Honduras where there were 4,200 ha in use in 1989. It is thought that the total area suitable for shrimp culture is between 20,000–25,000 ha.

In Brazil there are reportedly 3,800 ha of ponds. With a long coastline and a favourable climate, this country appears to have enormous potential for shrimp culture. A number of different species have been tried. Progress has been slow, apparently as a result of technical and administrative difficulties.

The area under cultivation in Peru is estimated to be 3,600 ha from which 2,190 t were reportedly produced in 1988. These figures would indicate an average yield of 600 kg $ha^{-1}yr^{-1}$. The government estimates that 5,000 ha of additional land are available. Shrimp culture is possible only in the extreme northern part of the coast. It is considered that the area under cultivation might increase to 8,000 ha.

The principal species cultured are *Pen. vannamei* (95%) and *Pen. stylirostris* (5%). There are three hatcheries in operation using nauplii from Ecuador.

In Panama 43 shrimp farms with a total area of 3,300 ha are under extensive cultivation. Production was reported to be 2,800 t in 1987 and 3,500 t in 1988. These figures would indicate an average yield of 1,050 kg $ha^{-1}y^{-1}$. Despite the fact that this country was one of the earliest to have major investments in shrimp culture, growth in the industry has been slow, chiefly as a result of lack of technical personnel, poor site selection (especially in relationship to the use of mangrove areas), lack of operating experience and political instability.

Colombia shows potential for development, with the area of ponds and production showing favourable growth. Production has increased from 1,500 t in 1986 to 3,500 t in 1988. Other countries in the region have less than 2,000 ha of ponds each.

If the situation in the capture as well as culture industry does not change quickly (in quantitative and qualitative terms) the industry will continue to lose established market outlets to Asian products. Latin American countries have the advantage of traditional relations and species preference in the United States and certain European markets, but are pressed to compete on price, not to mention consistent supply. For instance, Chinese whites are gaining market support with processors in the United States. Similarly, Australian product is penetrating the Spanish market for head-on shrimp.

ASIA

The shrimp industry in Asia has experienced profound changes over the last 10 years, mainly on account of developments in the culture of marine shrimp (Tables 9,10). These developments have brought about serious socio-economic and ecological repercussions on national and regional levels, and upset traditional world marketing structures.

Asia now accounts for about 60% of the world shrimp production, or in excess of 1.6×10^6 t, due to greatly increased aquaculture output.

The outlook for the Asian shrimp industry is brighter than for any other region because of its competitive position in terms of production costs, and consistent supplies. In addition, the processing sector is gaining the world's esteem because of its efficiency and high output of quality product.

Capture Fisheries

Capture fisheries have reached maximum levels in most countries. Slight increases may still be expected from improved handling and gear. Resource conservation measures are being imposed in the majority of countries

Inland capture of freshwater shrimp for export is limited. Landings appear to be affected by pollution and competition from the more readily available marine shrimp.

Culture

The marine shrimp aquaculture industry has developed rapidly and has reached the stage where mass production is a reality. This has mainly been the result of a production oriented mentality. Governments strongly supported this development as it was considered a potentially important source of foreign exchange and employment, with significant spin-off benefits.

The prime example is Taiwan where large volumes of shrimp were cultured at high profit margins. After initial hesitation and/or a period of adaptation of the culture technology to local conditions, production virtually exploded all over the region. *Pen. monodon* is the prime species cultured with the exception of China where *Pen. orientalis* is the principal species.

In most countries a number of favourable factors allowed rapid development of aquaculture:

- tropical climate
- sound resource of broodstock and/or wild fry.
- positive government support
- suitable species (*Pen. monodon*)
- tradition in culture of aquatic species.

The improving availability of formulated feed and hatchery-reared fry was another significant boost for the development of the sector.

Aquaculture has developed rapidly, particularly in Southeast Asia. On the Indian subcontinent development has been slower, mainly because of bureaucratic constraints and limited local investment capital and knowhow. Systems employed are primarily of an extensive nature.

The development of the culture sector in China shows a number of marked differences from other countries in the region:

- shrimp culture developed in the colder northern region
- the principal species is *Pen. orientalis*
- development is centrally planned
- mostly extensive operations.

Nevertheless, production also increased in China at an accelerated pace, initially due to a rapid increase in pond area. Currently, the culture of *Pen. monodon* in the more temperate southern provinces is also gathering considerable momentum.

The marine shrimp culture industry in Asia has reached a critical point:

- prices have dropped as a result of oversupply on the world market. Although the supply situation has returned to normal, price levels have remained depressed since the end of 1989. Farmers will have to decide whether to continue to increase production with current technology, or concentrate on efforts to improve efficiency in existing operations and develop more cost effective inputs.
- current output is basically limited to two species cultured to medium sizes. Species diversification could result in improved market movement and lower pressure on inputs.
- major investments are needed in research and

TABLE 9. Aquacultured shrimp production (1,000 t) from selected countries in the Asian Region. Source: FAO Yearbook of Fisheries Statistics and FISHDAB.

Country	1984	1985	1986	1987	1988	1989
China	22.0	35.0	70.0	153.0	180.0	190.0
Taiwan	5.0	17.0	33.5	65.0	75.0	45.0
Indonesia	33.0	39.0	48.0	55.0	82.5	90.0
Thailand	10.0	14.5	15.0	16.0	40.0	70.0
Bangladesh	11.5	12.5	13.5	14.5	18.0	20.0
India	26.3	26.5	27.9	25.4	33.6	35.0
Vietnam	4.0	7.0	7.0	7.0	15.0	25.0
Malaysia	–	–	–	2.0	3.0	3.0
Others	–	–	–	5.0	6.0	8.0
Total-Asia	145.3	185.0	290.8	408.9	488.6	506.0
Total-World	175.0	210.0	500.0	500.0	560.0	560.0

development to improve efficiency. The need for cheaper and more productive inputs and the current occurrence of various devastating diseases, clearly indicate the need for considerable investment in research and development.

Asia has contributed considerably to improving supplies to major world markets, even to the extent that it is harming its own industry. This situation seems to have resulted in more secrecy and a decrease in the flow of information on actual production estimates. Producers and exporters believe that information on production has a negative effect, basing their arguments on last year's experience. Traders in major markets respond with a wait and see position, resulting in small volumes being moved, little advance buying, little confidence in the future market, and consequently, a continuation of the depressed market prices.

INTERNATIONAL TRADE

Imports

World imports of fresh, chilled and frozen shrimp into the principal market countries during the period 1980–87 increased by 87% in volume and by 134% in value.

The dominant importing countries throughout the period were Japan and the United States. During the period 1980–1987 these two countries maintained their share of world markets, in terms of quantity, at 58%. During 1988 and 1989 imports into both countries have continued to increase although at a more moderate rate. However, the supply patterns by country of origin has experienced considerable changes particularly in the United States market. The EEC is the third largest market, and has shown considerable growth in consumption levels, while its growth potential is rated as impressive.

Growth in imports, by value, in the period 1980–1987 has been notably rapid in countries such as Singapore (1,750%), Italy (319%), Denmark (312%), Hong Kong (238%) and Spain (223%). The rapid growth in imports in such countries as Singapore, Denmark and Hong Kong has to be associated with an important re-export activity which has developed.

Japanese Market

Domestic landings in the period 1984–88 averaged about 50,000 t y^{-1}. Imports, during the period 1985–89 and in 1989 were 44% higher than they had been in 1985.

The share of imports in total supplies to the Japanese market increased from 61% in 1970 to 80% in 1980, while by 1988 it had reached 89%.

For many years India had been the leading supplier to the Japanese market. In 1986 and 1987 Taiwan took the lead, but in 1988 exports from Taiwan dropped by 54% in relation to the previous year and in 1989 only 8,900 t were exported. Indonesia and China assumed the leading position in 1988. In 1989 Indonesia assumed the top position with exports to Japan of 52,000 t (34% more than the second largest supplier, Thailand).

Notable increases in exports to the Japanese market in 1989 (compared to 1987) were achieved by Thailand, Indonesia, Philippines, Vietnam, and China.

The growth in imports during the 1980's has been the result of increased demand, caused by, among others, rising incomes, favourable price levels, together with the movement of the population into urban areas. Since 1985 the strength of the Japanese currency in relation to the United States dollar has also substantially contributed to Japan's strong import performance.

Declining prices have contributed to a signifi-

TABLE 10. Wild shrimp production (1,000 t) from selected countries in the Asian Region. Source: FAO Yearbook of Fisheries Statistics and FISHDAB.

Country	1984	1985	1986	1987	1988	1989*
China	207.1	229.2	200.1	192.5	583.6	580.0
Taiwan	na	100.0	107.7	137.0	126.5	85.5
Indonesia	132.9	144.1	157.3	167.8	167.8	170.0
Thialand	na	136.2	126.3	139.5	150.1	150.1
Bangladesh	61.0	70.0	73.0	74.0	75.0	75.0
India	203.1	232.5	214.7	216.7	216.7	210.0
Vietnam	na	52.0	54.1	55.4	56.0	56.0
Malaysia	na	70.1	69.0	72.9	72.9	72.9
Japan	62.9	55.0	47.9	47.8	47.8	45.0
Total	719.2	1151.1	1122.2	1171.6	1576.0	1519.5

*Estimated.

cant change in the pattern of consumption. In 1982 institutional consumption was reported to account for over 75% of total usage, with the remainder consumed at home. By 1988 home consumption had increased to 55% of the total usage.

Because of increased retail sales the Japanese market was able to expand further in recent years, despite the fact that institutional sales appeared to have reached saturation point.

No major increase in Japanese import and consumption levels are anticipated. The gradually weakening yen, signs of reduced growth in the national economy, increasing competition from other food items, e.g. salmon and beef, and the already high levels of per capita shrimp consumption, are all factors that undermine confidence in the future growth of the Japanese market.

United States Market

Domestic shrimp landings in the period 1985–1988 averaged 162,300 t y^{-1}, live weight. Domestic catches of tropical shrimp have remained stable for many years. Coldwater shrimp landings declined in the early 1980's, but have recently started to recover and in 1988 accounted for 25% of the total domestic landings. Production from domestic shrimp culture is negligible.

Imports increased each year during the period 1985–1988, and in the latter year were 40% higher in volume than they had been in 1985. In 1989 imports remained at the 1988 level. Imports slumped during the last quarter, when the market virtually collapsed due to an oversupply caused by dumping of Asian black tigers and white shrimp, deverted from the Japanese market.

The share of imports in total supplies to the United States market increased from 53% in 1970 to 55% in 1980 and by 1988 had reached 75%.

For many years Mexico was the leading supplier to the United States market, but this country has been unable to maintain its position. In 1987 Ecuador took the lead, but in 1988 was narrowly overtaken by China. Most of the product supplied by China and Ecuador is cultured white shrimp and these two countries together accounted for 37% of the total volume of United States imports in 1989. During 1989 imports from Ecuador dropped by 22% due to problems in their culture industry.

The most significant factor in 1988 was the sharp increase in imports from China (+145%) in relation to the previous year, a position maintained in 1989. Imports from Taiwan (-53%) and Mexico (-23%) declined sharply in 1988 from the previous year, as a result of problems in culture production and lower landings from capture fisheries respectively. During 1989 Mexico maintained this level (+15%) but Taiwan lost more ground as its exports for the year dropped by another 57% compared to 1988.

Headless shell-on shrimp is the predominant product form for imports and in 1988 accounted for 71% of total imports. During the period 1985–88 imports of headless shell-on product grew by 54%, while peeled shrimp imports increased by 18%.

In the period 1970–80 United States consumption of shrimp increased by only 9%. In the period 1980–88, however, it grew by 78% as a result of the increasing popularity of shrimp and improved availability. Still, per capita consumption in 1988 was a modest 1.1 kg (edible meat weight).

The drop in price levels for the medium sizes (20–25 and 26–30) during 1989 was the result of a substantial increase in supply of these sizes, mainly cultured product from Ecuador, China and Southeast Asia. The large sizes (under 15) followed suit as the price gap widened.

The prices for the smaller sizes held up relatively well in 1989 because of increased sales through retail outlets and the fact that imports of these sizes from Ecuador were much below normal (and anticipated) levels.

In recent years the pattern of consumption has changed. It is estimated that about 30% of shrimp is now sold retail, as compared to about 15–20% as recently as 5 years ago. Lower prices have enabled retail outlets to sell shrimp at prices which make it attractive in relation to competing products, and which provide favourable profit margins.

The current United States market can be described as unsettled as nobody seems to have a clear picture of what is happening. There is only scattered news on the production side, which is also mostly based on rumours. As a result trading is generally for immediate use only at depressed price levels. There is definitely no clearly defined direction. The United States market can be expected to have great potential in terms of an increase in imports although the current weakening of the economy will probably have a negative impact on growth. The lower value of the dollar and higher interest rates are additional negative factors. On the other hand, anticipated higher fuel prices could have a negative effect on domestic landings, leaving more room for imports.

European Market

With a total consumption of over 250,000 t in 1988, live weight equivalent, Europe follows Japan and United States as the third largest market for shrimp.

Coldwater shrimp (*Pan. borealis*), which is the major product in the Western and Northern European markets, is mostly supplied by countries from the north Atlantic. Declines in catches by Norway and the USSR have been compensated for by relatively stable landings in Greenland, Iceland, Faeroe Island and Denmark. The proportion of coldwater shrimp in the total shrimp supply to the European market declined from 49% in 1982 to 41% in 1988, although it increased in absolute terms from 81,000 t to 106,900 t during the same period.

Imports of shrimp into European countries in 1988 were 45% higher than they had been in 1985.

The increases in imports of tropical shrimp can also be ascribed, at least partially, to the strength of the European currencies in relation to the United States dollar and the slow growth in the supply of the preferred coldwater species. Price considerations may also have played a role in the growing importance of tropical shrimp.

Contrary to the preference for coldwater shrimp in northwestern Europe, consumption in southern European countries, especially Spain, France and Italy, is primarily directed towards tropical shrimp, and one of the most preferred product forms is head-on shrimp from Africa, the Mediterranean and Latin America. Despite consistent supply and price advantage Asian shrimp have not been able to make inroads in Spain and Italy. Quite the contrary can be said about Western Europe, which can be considered black tiger and chinese white territory by now.

Little impact is expected from the opening up of the eastern European markets in the short term. Incomes are too low.

Judging from the economic preference and current per capita consumption, Europe offers the most promising growth potential. However, it should be kept in mind that shrimp does not occupy the same status and popularity in Europe as it does in Japan and the United States.

Minor Markets

There are a number of important and rapidly growing markets such as Singapore, Hong Kong, Canada and Australia. In addition, the metropolitan areas in developing countries harbour a substantial number of wealthy people who do dine out frequently and like to consume shrimp. Their role in the world shrimp market will become increasingly important. For instance, Brazilian exporters indicate that they could sell the entire national production in the home market, and only export to earn hard currency.

Future Market Prospects

The sharp drop in world shrimp prices during the fourth quarter of 1989 has been a reminder to producers and traders that shrimp, like all traded commodities, is subject to fluctuations in price when the forces of supply and demand are out of balance or when a traditional trading pattern falls apart and uncertainty takes over. The rapid expansion in recent years of cultured shrimp production in Asia and Latin America caused a temporary oversupply on world markets. The sudden fall in prices was inevitable.

Other factors that contributed to the dramatic weakening in market conditions during the last part of 1989 were:

1. the oversupplied and temporarily saturated Japanese market
2. the gradual reduction in prices since early

1988
3. the increasing competition among exporters
4. the switch from a supply to a demand driven market
5. the marketeers in major markets not being ready for the new demand driven market situation.

In considering the future market prospects for shrimp over the next five to ten years it is important to maintain a focus on long term trends and underlying market forces, and to avoid being overly influenced by the recent dramatic events of 1989. To a certain extent this recent crisis has already been overcome, although at considerable cost. During most of 1990 the major markets actually experienced a shortage of certain species and sizes, as a result of production problems and sustained high consumption.

Overall demand for shrimp over the next decade will depend mainly on such factors as population growth rates; increases in disposable income; prices of shrimp; prices of meat, fish, poultry and other substitutes for shrimp; and consumer tastes and preferences. Forecasts of changes in demand for shrimp depend upon anticipated changes in these factors and on the responsiveness of shrimp consumers to these changes.

The World Bank predicts that the population growth rate in industrialised countries during the 1990's will be about 0.3% annually, while that of developing countries will be about 1.8% annually. Overall, the world population is predicted to grow at annual rate of approximately 1.4% during the 1990's. Although total population growth will affect overall shrimp consumption, it will largely depend on the increase in the number of people who can afford to buy shrimp, how much their disposable income will grow and how much of this total disposable income will be spent on seafood (i.e. shrimp).

The World Bank forecasts that the real Gross Domestic Product (GDP) in the industrial and developing countries will increase at average annual rates of 2.6% and 4.9% respectively over the present decade. This suggests a weighted average growth rate of GDP worldwide of approximately 3.5% and an average per capita income growth rate of about 2% annually in the 1990's.

Estimates of the income elasticity of demand for shrimp vary widely from market to market. In our opinion overall income elasticity of demand for shrimp will be less than 1.0. Using the estimate of slightly less than 1.0 as the future income elasticity of demand for shrimp, a worldwide population growth rate of 1.4%, an average growth rate of per capita income worldwide of 2%, and other factors remaining constant, shrimp demand should rise at an estimated annual rate not exceeding 2.5%, up to the year 2000.

With total world shrimp production in 1988 estimated at approximately 2.45 $x10^6$ t with demand expected to continue to grow at about 2.5% annually, the total world production for shrimp will have to rise to about 3.2 $x10^6$ t by the year 2000. It is not expected that there will be any significant increase in landings of shrimp from capture fisheries. A certain proportion of the required supplies will come from reduced post-harvest losses because of better handling and improved yields through new processing technologies and product development. Nevertheless, the major share of the additional supplies will have to come from culture operations which will have to grow from the 1988 level of about 560,000 t to about 1.3 $x10^6$ t in the year 2000. This implies an annual growth rate of cultured shrimp of about 7% over the period until the year 2000. Thus production will have to continue to increase at the 1985–90 rate, resulting in a cultured shrimp production at the year 2000 of 1.5 $x10^6$ t. Such a growth rate of cultured shrimp output appears highly unlikely without either a significant rise in real pond bank prices and profit margins approaching 1988 levels, or a major breakthrough in culture technology that will substantially lower production costs, and/or increase output.

Therefore our forecast is not one of an oversupplied market, although there may be periods of excess supplies, e.g. because of temporary favourable natural conditions. Price levels to the producer/exporter will very much depend on marketeers in major markets successfully promoting shrimp as a tasty, healthy, and value-for-money food item.